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ABSTRACT

The adoption and impact of curriculum innovation are most commonly researched in terms of roles that teachers and school administrators are expected to play. A study in New Zealand focused on the responses of students. This integrated studies project developed alternative approaches to the traditional junior secondary school curriculum. It included extensive use of computers and a enquiry-based approach that explored Maori and European cultures while integrating mathematics, history, and language arts skills. Data were collected from 3 cohorts of students each over 3 years to provide complete data on 415 students. Results show that students who elected to be involved in the integrated studies program had more positive attitudes toward computer use than those in the traditional school program, and they also reported more enjoyment of out-of-class activities. Students in the integrated studies program were significantly less alienated than their counterparts in the regular grade-9 programs, and academic achievement was also higher for English, mathematics, and science. Results demonstrate a lag of over 3 years between the implementation of the curriculum elements and their complete use, and that student attitudes toward the program developed favorably over time. This suggests the importance of support and encouragement for teachers as they work to implement the innovations. (Contains 1 table and 11 references.) (SLD)

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Curriculum innovation involving subject integration, field-based learning environments and information technology: A longitudinal case study of student attitudes, motivation and performance

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Abstract

The adoption and impact of curriculum innovation are most commonly researched in terms of the roles that teachers and school administrators are expected to play. Yet, the intention of such innovation is to enhance the quality of students' education. The results of recently completed New Zealand longitudinal research show not only positive learning outcomes for students (e.g., enhanced attitudes, motivation and performance), but also that students' favourable response to the innovation contributed positively to its adoption by the school in which the innovation took place. While the main focus of the paper is on description and illustration of the project, and documentation of its effects on students' attitude motivation and performance over five years, the role that teachers and key school administrators played is also documented and analysed. This is done in terms of the way sustained professional development assisted them to think differently about their practice and to become innovative.

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The adoption and impact of curriculum innovation are most commonly researched in terms of the roles that teachers and school administrators are expected to play. Yet, the intention of such innovation is to enhance the quality of students' education. The results of recently completed New Zealand longitudinal research show not only positive learning outcomes for students (e.g., enhanced attitudes, motivation and performance), but also that students' favourable response to the innovation contributed positively to its adoption by the school in which the innovation took place. While the main focus of the paper is on description and illustration of the project and documentation of its effects on students' attitude motivation and performance over five years, the role teachers and key school administrators cannot be ignored. They made the project possible by their willingness to be involved, by changing the way they think about learning and teaching and by developing and applying learning and teaching strategies quite different from those commonly practised in New Zealand secondary schools. Thus, the project was innovative not just in terms of the new type of program that it implemented but also in the ways that it assisted teachers to change fundamentally the way they think about many aspects their professional practice. The project demonstrated that if teachers are to change their practice they must first change the they think about their practice. The change was facilitated by a sustained program of teacher professional development and support. With students, the project created environments that encouraged them to learn in new ways and develop positive attitudes to learning.

Accordingly, the paper addresses three main topics: (i) the project itself incorporating description of an exemplary program and how it worked; (ii) a report of key aspects of the professional development program for teachers; and (iii) the results of research demonstrating enhanced student attitudes, motivation and performance.

The Integrated Studies Project

The integrated studies project reported in this paper developed alternative approaches to the traditional junior secondary school curriculum (grades 8-10) found in New Zealand. Programs were designed around the extensive use of computers, out-of class activities, and the integration of core subjects (English, mathematics, science and social studies). An enquiry-based method was used by teachers and students to investigate a range of real-world problems requiring an across-the-disciplines approach, the gathering of data in the field, the extensive use of computers in the storage, retrieval and processing of the data, and in the writing of reports (Nolan & McKinnon, 1991; Sinclair, 1993). One example of such a program is presented to illustrate the interaction of the three components of the project in the integrated setting.

Grade 9 - The Bicultural Journey

In New Zealand, Grade 9 tends to be the difficult year of secondary school for students and teachers alike. First year of high school euphoria has all but worn off, the focussing effect of grade 10 external School Certificate examinations remains distant, and typically, adolescents at this stage tend to feel that school has little to offer them. The challenge for the project, therefore, was to devise an educational program that would capture students' interest, by challenging them intellectually, emotionally and physically, yet accomplish the educational objectives of the grade 9 common curriculum.

A "bicultural journey" was seen as the means of achieving this end in the context of the overall theme of social change in grade 9. The journey involved a two day walk along a rugged coastline to the mouth of a prominent river retracing a trade route commonly used by the early Maori[1]. Along the way, students conducted a variety of studies with a view to seeing and experiencing this part of the world through both Maori and European eyes. The journey ended when the students arrived on the main Maori marae[2] of the area. The students were prepared for the visit by learning the appropriate protocols and etiquette expected of visitors on arrival and during a visit, by gaining a rudimentary mastery of Maori language, by learning traditional arts and crafts, by understanding some of the history of the area and the genealogy and mythology of the local tribe, all of which were taught by a Maori teacher on the school staff.

In the build-up program, students were given responsibility for many aspects of the planning and organisation of "the Journey", for getting themselves physically fit and for completing preparatory studies. Computer applications featured in most of these. Working in self selected groups, the students were taught how to use spread sheet, data base and graphing programs as a matter of course in: monitoring physical fitness e.g. recording resting and recovery heart rates and performance data; estimating and recording the costs of food, transport, and accommodation; and preparing menus and rosters. Students routinely used the word processor to produce notices to parents and students and letters to external agencies and organisations. This demonstrated to them the word processor's utility as a writing tool which they later used extensively in a wide range of compositions arising out of the journey.

Early in the piece, the European teacher of mathematics discovered in Maori weaving patterns a practical way to teach geometrical transformations. Students developed a superprocedure in LOGO for replicating the pattern and designing new ones. This was a significant breakthrough for the teacher who began to see possible other ways in which mathematics might be taught in the context of other subjects or by using practical activities that were interesting to students. Specific topics such as hypothermia, human physiology, food, nutrition and clothing were also perceived as relevant because they were directly related to the planned activities and events of the journey and they were taught in this light by both the mathematics and science teachers. The journey itself challenged the students, emotionally and physically, and for the most part, they derived personal satisfaction from and found intrinsic reward in their accomplishments. The journey provided first hand experience of the environment that the Maori had lived in prior to European settlement and which the Europeans dramatically changed, through deforestation, farming and recreational pursuits. Teachers and parents accompanying the students were both European and Maori, thus ensuring that explanations and interpretations of phenomena were given from the viewpoint of both cultures. The field activities centred around specific bicultural studies of beach, stream and lagoon environments which involved: surveying the vegetation and other beach resources using standard sampling procedures from geography; mapping the modern day trails and reconstructing early Maori trade routes; examination and imaginative reconstruction of a Maori Midden and pre-European camp

[1] The original inhabitants of New Zealand
[2] A meeting place

site through questioning, landscape sketches, taking an inventory of contents and note taking.

To complement these activities, students collected European and Maori people and place names as part their genealogy/history study and they read and learned Maori myths and legends. Evening studies provided opportunities for discussions, reflection, data analysis and note writing. Once welcomed onto the Marae, the students became Tanga Te Whenawa, that is, they were accepted into the tribe, were treated with affection as an integral part of the community, participated in cultural activities and were taught a great deal by the elders to whom they showed deference and respect. Later written accounts and comments expressed the profound and enduring effect that the Marae visit had on the students.

In follow-up studies, the same computer applications as used in the build-up, were again employed in variety of ways. While the data base and graphing programs were used extensively, the word processor was the application most commonly used mainly because much of the in-class work concentrated on written assignments. These were squarely based around "Journey" experiences and involved a full range of compositions covering imaginative pieces, personal diaries, short stories, myths and legends, research and scientific reports and the script for a documentary video, based on their Marae experience, which addressed Treaty of Waitangi[3] topics of contemporary concern. In all this, students not only mastered the word processor, they discovered its value as a writing tool helpful in all the key processes such as planning, composition and editing.

Students were also introduced to desk-top publishing which further enhanced the range of composition and publishing capabilities they developed and effectively used in the production of class and school publications based on their experiences and follow-up work. More specifically, statistical knowledge and skills were learned by using spread sheet and graphing programs to analyse vegetation and topographical data that the students had collected and were required to write up as science, mathematics, social studies, and sometimes simply as integrated studies reports. In a food and nutrition project that arose out of earlier work on menu construction, students used a food and nutrition data base, which they helped a teacher design, for analysing New Zealand adolescent food preferences and food consumption patterns. Many began to employ the information they gained to manage their own diets and follow a weight control program. Here, the graphing program was both popular and useful for tabulating progress in graphical form.

Beyond this specific part of the unit on change, these grade 9 students used the full range of integrated applications and increasingly others in programs based the study of people and places in the city and elsewhere. Throughout the year long theme on change, both product and process were important as the students gained new insights and deeper understanding of the cultural, economic, natural and political world in which they lived.

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[3] A treaty between the Maori and the English signed in 1840, the interpretation of which is still contentious.

Professional Development of Teachers

From the outset the research and development team recognised that teacher professional development was a crucial factor for successful implementation of each of the key components of the project. In the original Project Proposal a request was made for substantial teacher release time to conduct professional-development activities: 108 teacher release days in the first year, 144 in the second and 180 in third. In reality very little time was actually delivered by the Department of Education - 30 days for seven teachers in the first year, 20 days for 10 teachers in the second, and 20 days for 20 teachers in the third.

The form of early professional development endeavours was therefore dictated by the amount of non-contact time available to the teachers. With the exception of the Integrated Studies Coordinator, who received an allocation of six pupil-free hours per week out of a total of 25, the remaining teachers had to teach between 20 and 24 periods each. Given this situation, professional development took the form of research staff working cooperatively with teachers in the classroom and during out-of-school hours. The work involved designing instructional programs, team teaching and giving demonstration lessons, providing technical support and individualised instruction on request, developing out-of-class activities and, accompanying teachers on these activities.

Design and development of field trips and integrated sequences of work proved to be the least problematic in the early stages since they drew on curriculum areas in which teachers were confident and had some experience. With computers, the reverse was the case. The coordinator of the program was the only teacher who had any prior experience in using computers in the classroom.

Despite the lack of expertise, many gains were made. All integrated studies classes used word processing in most aspects of their work. All classes had applied the database and the spreadsheet to a variety of studies generated as a result of issues and topics investigated in their integrated programs. There was a high level of enthusiasm amongst the students for working with computers.

In contrast, the teachers were diverse in their appreciation of how the computer might be used, diverse in their levels of competency and confidence in using the various applications, and diverse in their attitudes and valuations of the computer itself as an educational tool. It was recognised that if a higher minimum level of teacher competence and confidence was to be achieved then a different approach to professional development was required. The Concerns-Based Adoption Model (CBAM) developed by researchers at the University of Texas at Austin (Hall, Wallace, & Dosset, 1973) was selected for two reasons. First, it provided a conceptual framework for examining the process of innovation adoption. Second, it provided an empirically validated process for the collection of research data to be used for the design and delivery of further professional development programs.

During the third year of the project, an extensive professional development program was implemented by the researcher and monitored using the Stages of Concern (Hall, George & Rutherford, 1979), Levels of Use (Loucks, Newlove & Hall, 1975) and

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Innovation Configuration Checklist (Heck, Stiegelbauer, Hall & Loucks, 1981) instruments developed for the CBAM. The outcomes of the professional development program are reported more fully in McKinnon and Nolan (1990).

Within the CBAM the process of innovation adoption is dialectical in character involving constituent processes of feeling, action and choice. Initially individuals feel a sense of concern related to a specific aspect. Once identified the concern must be addressed in terms of specific actions aimed at resolution of the concern. Resolution in its turn involves conscious choices about further involvement which in its turn gives rise to new and different concerns.

Experiences in the project exemplified the dialectic in action. In some instances teachers' adoption of computers was relatively unproblematic. In these cases, the teachers came into the project with a commitment to master the computer and to apply it in the classroom. For example, one teacher took a computer home during the long Christmas vacation and returned in the new school year fired with enthusiasm to apply his new found skills. In contrast, other teachers showed little enthusiasm for the project and were reluctant to spend time in learning how to use computers. With these teachers, there was a mismatch between their concerns and those of the initiators of the project. Consequently, professional development activities failed to meet their needs. Eager to make progress, but lacking insight into the dialectical nature of the problem, the initiators constructed early professional development activities to meet their own concerns rather than those of the teachers.

An example illustrates both the initial mismatch and the dialectic in action as the dissonance was resolved. At the inception, small numbers of computers were placed in the integrated studies classrooms. Researchers were concerned, however, that students were not developing levels of competency and skill commensurate with their ability and the enthusiasm they displayed for working with computers. Moreover, progress in this environment was unlikely to occur unless associated problems of disk failure, student access and teacher management were also addressed and resolved. The researchers, in conjunction with the teachers, decided that it would be expedient to move the computers into a laboratory. In the laboratory, teachers felt more secure in the knowledge that they could resort to tried and true whole-class instruction and discipline methods.

The physical set up of computers in the laboratory permitted the teacher, standing at the front of the class, to maintain surveillance over the whole class. While this environment appeared to encourage progress on a common front, students inevitably progressed at different rates. As the teacher responded to one individual's needs, others either had to wait or seek help elsewhere. Typically, peer tutoring began to occur and the teacher had little choice but to accept this as a workable basis for the conduct of the class. This pattern became established and management methods were adapted. In response teachers could not but change or adapt their methods and strategies to meet the demands of the new situation.

Just as the implementation of the project was daunting for the teachers, the researchers were also faced with the equally daunting task of learning new roles working with and along side teachers in the process of innovation adoption. Moreover, being the

initiators of the project, they had to learn to down play their concerns in order to develop and maintain teacher commitment to, and enthusiasm for, the goals and approaches.

The CBAM, however, provided a useful framework within which to analyse the ongoing dialectic of change. The CBAM instruments provided important diagnostic information for staff developers. This permitted the selection of more appropriate intervention strategies and tactics to facilitate innovation adoption and use while minimising the trauma of change (McKinnon, 1995).

Students' Attitude, Motivation And Performance

An embedded case-study methodology (Yin, 1994) was employed to assess the impact of the project on students' attitudes, motivation and performance. Within the case study, a quasi-experimental longitudinal cohort design complemented by qualitative data was used to compare students in the integrated studies program with their peers who had elected to remain in the traditional program (McKinnon, 1995).

Data relating to the project were collected from three cohorts of students each over three years using a variety of methods. That is, complete data on 415 students in three cohorts were collected over a period of five years. The Adolescent Theories of Education questionnaire (Nicholls, Patashnick & Nolen, 1985) was employed to monitor the development of student attitudes and motivation using the scales for achievement motivation, task orientation, academic alienation and satisfaction with school. The Computer Attitudes Questionnaire reported by Bear, Lancaster and Richards (1987) was further developed to monitor student attitudes towards: learning with and about computers, personal enjoyment and relevance of using computers; the educational value of out-of-class activities, and personal enjoyment of these; and, the educational value of the integrated curriculum. Common school tests and the New Zealand School Certificate examination results in English, mathematics and science were used as indicators of educational performance. In addition, students were interviewed about their experiences within the project and textual data were obtained from written comments made when questionnaires were completed.

Results

Results show that students who elected to be involved in the integrated studies program had significantly more positive attitudes towards computer use than those involved in the traditional school program and they reported significantly more enjoyment of out-of-class activities. While these out-of-class activities were in operation, students in the project had significantly more positive attitudes towards their educational role. As expected, students in the project had significantly more positive attitudes towards subject integration than their peers in the traditional program.

Scales relating to achievement motivation, task orientation and satisfaction with school yielded few significant differences. There were, however, significant differences in the scale involving academic alienation. Here, students in the integrated studies program were significantly less alienated from school work than their peers in the traditional program. Specifically, these students were more committed to avoiding school work,

preferred easy work, and hoped to do well without trying. It is notable that while all students' academic alienation increased with time, the students in the integrated studies program remained more satisfied with school learning than their peers in the traditional school program (McKinnon, 1995).

Interview data provided additional evidence for the extent to which the students in the integrated studies program were more highly task oriented and enjoyed school more than their peers in the traditional school program. Students' written comments were classified according to a small number of themes evident in their responses. Analysis of these themes revealed that, for those individuals who chose to express an opinion, students in the integrated studies program expressed significantly more feelings of empowerment and optimism, they enjoyed school more, and they also appear to be less critical of their teachers and the school compared with their peers in the traditional program. Many comments related to the developing expertise exhibited by their teachers in using computer applications (McKinnon, 1995).

The performance outcome measure of School Certificate examination success showed that the achievements of students involved in the project were significantly better in English, mathematics and science than students in the traditional program.

Overall the research demonstrated that the approach had significant positive effects on students' enjoyment of school and schooling, their more entrenched attitudes, motivation to learn, and their educational performance.

The Interaction Of Teacher Expertise And Student Attitudes

While the outcomes of the project evident from the data obtained from students reflects favourably on the project, there were interesting patterns that emerged over the five year time span during which data were collected that inform innovation adoption and implementation research. Specifically, the transformation in teaching practices did not happen immediately and considerable delay was evident before impacts were detected in students' attitudes and motivation. These latter changes were manifested in slight year-by-year increments in each successive cohort's attitude scores towards using computers and out-of-class activities. It seems that there are consequent effects of teacher expertise in using innovations on the students themselves in terms of their attitudes and motivation.

One example is used here to illustrate the delay in impact on students' attitudes. Table 1 shows the means and standard deviations of students' attitudes towards learning with and about computers. Occasion 1 is a measure of attitudes on entry to high school with Occasions 2, 3 and 4 being at the end of each of the first, second and third years of junior high school respectively. The first cohort of students were not surveyed on Occasion 1 as the questionnaires were not ready at that time. The scale scores show, however, that there is an increasingly positive attitude towards this dimension of using computers with each successive cohort. There is also a significant decay in students' attitudes in all cohorts with passing time ($F=31.14$, $df=2$, $p<0.0005$). These observations were explored through interviews with a number of students in the third year of the project.

TABLE 1

Means and Standard Deviations for Students' Attitudes Towards Learning With and About Computers

	Occasion 1		Occasion 2		Occasion 3		Occasion 4		N
	Mean Score	Std Dev	Mean Score	Std Dev	Mean Score	Std Dev	Mean Score	Std Dev	
Cohort 1	.	.	19.3	5.6	17.9	5.7	16.9	6.0	126
Cohort 2	22.2	5.0	20.1	5.4	18.2	6.2	18.4	6.3	157
Cohort 3	22.3	5.3	21.2	5.7	19.8	5.6	18.5	6.2	132

The interviews provided many interesting insights into the students' experiences of the various components of the integrated studies program. The following comment is from a grade 8 student in the first year of high school. The student was asked if he had any opinions about using computers.

> "They are stupid things sometimes, you can't get them to do anything. I like using them but I wish I knew more about them though. I wish they **(the teachers)** taught us a bit more about how to use them, because sometimes you're on the edge of something and you delete it and your whole page gets wiped out or something, and [the teacher] she says "Oh well", and you have to start all over again. I like using them though."

Here the student seems to feel that he needs to know more about how the computers and software work so that he doesn't waste time and lose work. The student expresses a desire for the teacher to teach them a bit more on how computers work so that the losing work situation doesn't arise. The comment also serves to illustrate that the teacher apparently does not know how the computers do work with the student's paraphrasing of the teachers' reaction as "Oh well".

The lack of expertise on the part of the teacher was further illustrated later in the interview by the first student's peers making the comments "Miss Mooney couldn't get it to work." and "[She] kept getting the wrong disk.". Finally one of the students indicated that despite the teacher's lack of expertise, they eventually managed to work it out "Yea, we finally worked it out. The teachers don't know much..... "What are you doing? What are you doing? Help." and the second student claiming "We just teach ourselves, sort of thing, as we go along."

Negative comments such as these serve to illustrate how teacher expertise in the technical side of running applications programs from a network seems to interact with students' attitudes. It would, therefore, not be surprising to detect year by year increases in students' attitudes as the teachers acquire the necessary expertise. Indeed, in this scale and in others related to the three components of the integrated studies project there are small, non-significant year by year increases in students' attitude

scores. In the Within-Subject analysis there are significant Cohort by Occasions interactions for attitudes towards computers and out-of-class activities. The patterns of attitude development generally show that for the first cohort, there is an increase followed by a decrease in score from Occasions 2 to 3 to 4, while for the second cohort an increase followed by stability, and for the third cohort stability followed by an increase from Occasion 3 to 4. Perhaps the teachers were acquiring the skills that are necessary to influence positively the attitudes of their students.

The significant decay in attitude score with respect to computers may in part be due to the fact that the students had extensive exposure to computers during their school week and that they came to see the computer as just another tool like a calculator or pencil and hence habituating to its presence. This was explored extensively through interviews with students and is perhaps a reasonable explanation for the decay. As one student claims "They're an aid, sort of like a tool just like a pen.". Despite the decay in the scale scores, however, during interviews students still maintained that computers were personally relevant to them and that they enjoyed using them.

The remaining scales assessed students' attitudes towards out-of-class activities and subject integration. The out-of-class activities scale showed an increasing trend with passing time. That is, as the students experienced these activities they became more positively disposed towards them. In addition, each successive cohort expressed more positive attitudes than the previous ones. One particular comment draws attention to the importance of actively doing things rather than passively listening.

> "Sometimes you remember things better if you actually see them, do them. You can always just sit in the class and write down notes for a whole year and you wouldn't learn as much as if you're actually doing it."

The same pattern of attitude development was evident for the three cohorts as for the scale on learning with and about computers. That is, for first cohort, there is an increase followed by a decrease in score from Occasions 2 to 3 to 4, while for the second cohort the attitude scores are stable, and for the third cohort stability followed by an increase from Occasion 3 to 4. It appears that again the teachers were acquiring expertise both in planning educationally and personally interesting activities for the students and in integrating them into the curriculum. A similar pattern was evident for the scale measuring students' attitude towards subject integration

Discussion

Innovation adoption and implementation is a slow process. Many cases are well documented in the literature that illustrate this fact well. In this project, teachers took considerable time to come to terms with each of the design elements and implement them in educationally sound ways. The data collected from the students indicated that there was a lag of at least three years between implementation and sustained use of the elements, and the detection of changes in student attitudes that could be attributed to their use. This finding alone has important implications for educational reformers, administrators and politicians. In addition, the project research team were sensitive to

the formative changes that were necessary by virtue of the fact that they were based at the school site.

For educational reformers it would seem that sustained effort is one of the requirements to drive the adoption and implementation of innovation. At the same time it is necessary to be sensitive to the results of formative evaluations so that changes can be made to accommodate the needs of those who have to implement it while still retaining the intention of the original innovation. This means, in essence, that the innovation has to evolve in response to the differing needs of students and teachers alike. The "fidelity model" assumes that there is a fixed innovation well specified in advance that has to be adopted and implemented. In education, this seldom appears to be the case. In the project reported here the evolution continues to this day. The school has assumed ownership of the project and it has now become 'routine' for that setting with all students and teachers engaging in integrated studies.

Administrators should recognise and understand that, in addition to the time required to change things, professional development of teachers is a major factor in the process of successful innovation adoption. As was mentioned above, the process is dialectical in character involving constituent processes of feeling, action and choice. If concerns are addressed successfully then participants make decisions either to continue, or not, for reasons that are both educational and personal. The innovation to be adopted, therefore, must be capable of being modified in response to the criticisms levelled at it.

The assumption by some administrators, and many politicians, that there are simple answers to educational issues and problems which can be encapsulated as "innovations" and introduced to school systems is not realistic. Rather, they must recognise the evolutionary nature of the dialectic as teachers make choices about the educational practices they are expected to adopt and implement in their classrooms.

It is clear from this project that educational administrators and politicians must be prepared to encourage and support teachers over a considerable period of time as educational innovations are introduced into schools. This will, in all probability, be increasingly the case as systemic changes to education gather pace and teachers are faced with numerous new challenges to their practice.

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